

**PRELIMINARY
LICHEN BIOMONITORING PROGRAM
AND AIR QUALITY BASELINE**

**IN SELECTED CLASS I WILDERNESS AREAS
OF CORONADO, COCONINO, KAIBAB, PRESCOTT AND TONTO
NATIONAL FORESTS, ARIZONA**

COPY

FINAL REPORT

SIERRA ANCHA WILDERNESS AREA

Arizona, Gila County
Tonto National Forest
Sierra Ancha Wilderness Area

SUBMITTED BY

**LARRY L. ST. CLAIR, Ph.D.
ASSOCIATE PROFESSOR OF BOTANY
AND CLAYTON C. NEWBERRY, RESEARCH ASSOCIATE
DEPARTMENT OF BOTANY AND RANGE SCIENCE
BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH 84602**

11 JULY 1991

Table of Contents

Introduction	Page 2
Methods	Page 5
Results and Recommendations	Page 6
Bibliography	Page 49

INTRODUCTION

Project objectives:

1. Collect, curate, and identify lichen species from selected sites in the Sycamore Canyon, Pine Mountain, Mazatzal, Sierra Ancha, Superstition, Galiuro and Chiricahua wilderness areas.
2. Identify potential sites in each wilderness area for establishing lichen monitoring transects and plots.
3. Identify and collect pollution-sensitive lichen species for elemental analyses from 5-7 reference sites in each wilderness area. Rare species will not be sampled for analysis, but their distribution will be noted.
4. Determine baseline thallus concentrations of sulfur, lead, and copper, using ten replicate samples of one documented pollution-sensitive species from each wilderness area.
5. Prepare and submit a draft report by 28 December 1990.
6. Prepare and submit 3 copies of a final report detailing the results of this study by 11 July 1991. This final report will include:
 - a. a map and a brief habitat description of the study sites in each wilderness area, and reasons for their selection.
 - b. a preliminary list of lichen species for each wilderness area with relative abundance and substrate data for each species.
 - c. a list of pollution-sensitive or potentially pollution-sensitive lichen species for each wilderness area.
 - d. color photographs/slides of lichens known or suspected to be sensitive to specified air pollutants for each wilderness area.
 - e. baseline concentrations of lead, sulfur, and copper for one indicator species from each wilderness area.
 - f. a map of recommended sites for establishing transects and plots for future long-term monitoring.
 - g. a list of references, protocols, equipment and supplies used in this study.
 - h. other pertinent information or unusual observations.

Lichens as sensitive receptors:

The use of lichens as bioindicators of air quality is a well-documented procedure (Ske 1979; Richardson & Nieboer 1981; Fields & St. Clair 1984; St. Clair 1989; Rope & Pearson 1990). Hale (1983) noted that lichens have been used in three ways to monitor the effects of air pollution on biological systems: 1) elemental analysis of lichen tissues, 2) mapping of all

(or selected) lichen species found in areas adjacent to pollution sources, and 3) transplant studies. Currently, the most common approach involves a floristic survey and elemental analysis of tissues from selected indicator species (St. Clair 1989; Wetmore 1981, 1989).

Because lichens accumulate many different pollutants from atmospheric outwash, lichen tissues (or thalli) provide a record of the kinds and relative quantities of pollutants in any particular airshed (Gough & Erdman 1977; Schutte 1977; Wetmore 1989; Rope & Pearson 1990). Pollution patterns for specific elements can be monitored over time by determining thallus growth rates and elemental concentrations in excised portions of the thallus (Lawrey & Hale 1981). Lichen physiological processes indicate pollution-related damage long before other, more visible changes in color, morphology, or community structure can be detected or even monitored (Sundstrom and Hallgren 1973; Fields and St. Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Wetmore 1981, 1989; Rushforth et al. 1982). As certain lichen species form particular substrates are inherently more sensitive to airborne contaminants, air quality can be effectively monitored by occasionally reevaluating lichen community and/or physiological parameters. Pollution-related changes can then be documented by comparing follow-up data to the original baseline data.

General habitat description for Arizona:

The state of Arizona includes several of North America's major biotic provinces: Sonoran, Chihuahuan, Mojave, Great Basin, and Colorado Plateau deserts; Rocky Mountain, Sierra Madrean, encinal, and pinyon-juniper woodlands; and inland chaparral. Elevation ranges from less than one hundred feet above sea level in Yuma County to over twelve thousand feet in Coconino County. Precipitation varies, but almost all portions of the state are watered to some extent by winter rain or snow and summer monsoons, with occasional chubascos in early fall. The Mogollon Escarpment divides Arizona's two major geologic provinces: the Basin and Range Province to the south and west, and the Colorado Plateau to the north and east. This project has involved a preliminary survey of seven of the eight Class I Wilderness areas in Arizona (figure 1).

General description of the Arizona lichen flora:

With over 600 species reported, Arizona's rich lichen flora results from the state's habitat diversity. The forests of the White Mountains, the Mogollon Escarpment, the Chiricahuas, and other high elevations throughout the state, also the encinal of Cochise and eastern Pima counties, support a rich epiphytic lichen flora. Crustose forms predominate on igneous substrates of the southern deserts and sedimentary rocks of the Colorado Plateau.

Bibliography of lichen studies in Arizona:

Darrow, R. A. 1950. The arboreal lichen flora of southeastern Arizona. *Am. Midl. Nat.* 42:484-502.

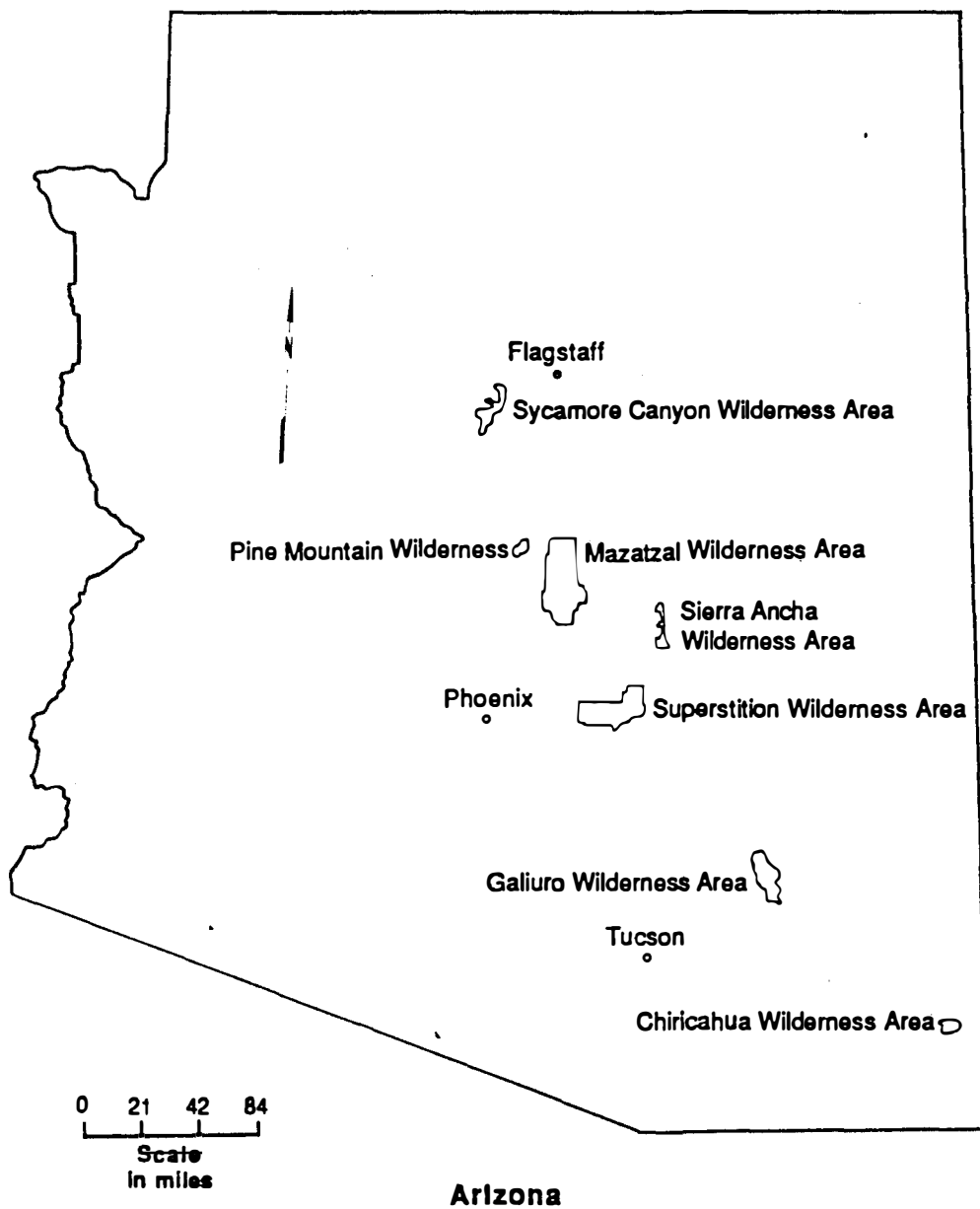


Figure 1

- Flowers, S. 1963. The lichen and moss flora of Betatakin Canyon and vicinity, Navajo National Monument, Arizona. Univ. Utah Div. Biol. Sci. Misc. Pap. 10pp.
- Johnsen, A. B. 1965. Some Lichens from West Fork, Coconino County, Arizona. The Bryologist 68: 241-243.
- Nash, T. H. 1973. Additions to the lichen flora of Arizona I. The Bryologist 76: 545-547.
- , 1974. Lichens of the Page environs as potential indicators of air pollution. Journ. Ariz. Acad. Sci. 9:97-101.
- , 1975. Lichens of Maricopa County, Arizona. Journ. Ariz. Acad. Sci. 10: 119-125.
- , 1976. Lichens of the White Mountains, Arizona. Journ. Ariz. Acad. Sci. 12: 53-56.
- , 1985. Additions to the lichen flora of Arizona III. The Bryologist 88(1): 19-22.
- & A. B. Johnsen. 1975. Catalog of the lichens of Arizona. The Bryologist 77: 472-474.
- & W. Weber. 1974. Additions to the lichen flora of Arizona II. The Bryologist 77: 472-474.
- Nebeker, G. T. & L. L. St. Clair. 1984. The lichen flora of Navajo National Monument, Arizona. Mycotaxon 19: 413-422.
- Rudolph, E. D. 1953. A contribution to the lichen flora of Arizona and New Mexico. Ann. Mo. Bot. Gard. 40: 63-72.
- Weber, W. A. 1963. Lichens of the Chiricahua Mountains, Arizona. Univ. Colo. Stud. Ser. Biol. 10: 1-27.

General habitat description for Sierra Ancha Wilderness Area:

The Sierra Anchas are an extremely rugged mountain range composed of Precambrian schist and younger conglomerates, shale, and quartzite. Elevation varies from about 4000 ft. to 8000 ft. Inland chaparral predominates in the lower elevations and mixed conifers in the upper, with deciduous riparian areas in narrow canyons.

Likely pollution sources impacting the Sierra Anchas are the Phoenix metropolitan

area and the Globe copper smelter.

METHODS

Procedures for selecting reference sites:

Specific locations for specimen collection (reference sites) in the wilderness were determined in consultation with Forest Service personnel. Sites were selected for accessibility, substrate diversity and habitat diversity. Specifically, occurrence of unusual geologic substrates, vascular plant communities, soil types, mesic canyons, and spring or wet wall areas were given particular consideration. Baseline data from the reference sites (species diversity, relative abundance, and elemental analysis data for indicator species) forms the foundation for evaluating future air pollution-related changes in lichen communities.

Collection, preparation and identification of lichen specimens:

Because lichen distribution is directly influenced by substrate, moisture, and sunlight, all available substrates and habitats around each reference site were carefully examined. Small amounts of each lichen species was removed directly from the substrate where possible, or, depending on the species, with small pieces of bark, soil or rock.

Specimens were put in carefully labeled paper sacks and taken to the BYU Herbarium of Nonvascular Cryptogams, where they were washed, curated, and placed in permanent herbarium packets labeled with collection site, habitat and substrate information. Species were identified using standard lichen keys and taxonomic treatises. Where appropriate standard chemical and thin-layer chromatography techniques were used to finalize species identifications. A permanent collection of the lichen species from each reference site has been prepared and will be maintained in the BYU Herbarium of Nonvascular Cryptogams. As requested by the Forest Service a set of duplicate specimens will be sent to the Lichen Herbarium at Arizona State University.

Collection of lichen thalli for laboratory analyses:

After careful consideration of species abundance, substrate, growth form, documented/suspected pollution sensitivity, and distribution patterns of the lichens at each reference site, 3-5 taxa were designated as indicator species for all laboratory chemical analyses.

At all reference sites sufficient material (10-15 grams) of each indicator species was collected for laboratory analyses. This material was stored in Hubco cloth bags to prevent sulfur contamination. One or two indicator species from one reference site was analyzed for sulfur, lead and copper, some of the most common air pollutants in the general vicinity of the wilderness area. Analysis for these pollutants was determined in consultation with Forest Service personnel. Excess material for all indicator species is currently stored in Hubco cloth bags at the Herbarium of nonvascular cryptogams at Brigham Young University.

Determination of elemental concentrations in lichen tissues:

In the laboratory, all surface debris was carefully removed from elemental analysis samples. Samples were then oven dried and ground to powder. Ten 500 mg replicates of one - two indicator species from one reference site in the wilderness were then analyzed for sulfur, lead and copper. Following digestion of samples with nitric and perchloric acid, lead and copper content was assessed using atomic absorption spectrophotometry. Sulfur was subsequently analyzed turbidimetrically using Barium chloride (BaCl_2). All analyses were performed by the Brigham Young University Plant and Soil Analysis Laboratory.

RESULTS AND RECOMMENDATIONS

Habitat information and specific location for each reference site:

In Sierra Ancha Wilderness Area lichens were collected around Aztec Peak, along USFS Trail 140, and up Devil's Chasm. Aztec Peak, at 2362 msm (7748 ft.), is the highest point in Sierra Ancha Wilderness. Vegetation on Aztec Peak consists of mixed conifers, Gambel oaks and shrubby dicots, and lithology consists mostly of basalt and sandstone. USFS Trail 140 descends west to east from Aztec Peak to the head of Devil's Chasm, or from 2216 msm (7270 ft.) to 1975 msm (6480 ft.). Vegetation along Trail 140 changes with decreasing elevation, from mixed conifers near Aztec Peak to alligator juniper, pinyon pine, beargrass, agave and prickly pear near the head of Devil's Chasm. Devil's Chasm, starting at 1036 msm (3400 ft.), is a zone of cottonwoods, sycamores, and other mesic forms restricted to the narrow riparian zone in the chasm. The steep, exposed walls are characterized by Sonoran Desert vegetation near the east-facing mouth of the chasm trending to xeric junipers, pinyons, etc, deeper into the mountain towards Trail 140. Figure 2 details collections sites for the Sierra Ancha Wilderness Area.

Preliminary observations and recommendations:

1. Sierra Ancha Wilderness Area has a diverse and abundant lichen flora. A total of 101 species in 48 genera were identified from this wilderness area (see "Checklist of Lichen Species Sierra Ancha Wilderness Area, Arizona" for details). This list represents approximately 45- 55% of the total lichen flora for the wilderness. All growth forms are represented in the flora. The flora is dominated by crustose species (43% or 43 species), followed by foliose species (39% or 39 species), fruticose species (7% or 7 species), umbilicate species (7% or 7 species), and squamulose species (5% or 5 species). Rock and bark lichens dominate the flora (53% saxicolous and 47% corticolous) with one terricolous species.
2. The vicinity of Aztec Peak was the richest of the three sites sampled for lichen diversity and abundance in Sierra Ancha Wilderness Area. Aztec Peak (particularly the north-facing exposure immediately outside the wilderness boundary) was especially rich in fruticose corticolous forms, which are rare in the other sites. Crustose and umbilicate saxicolous forms were also abundant around Aztec Peak.
3. Foliose and crustose corticolous lichens increased in size, number and diversity

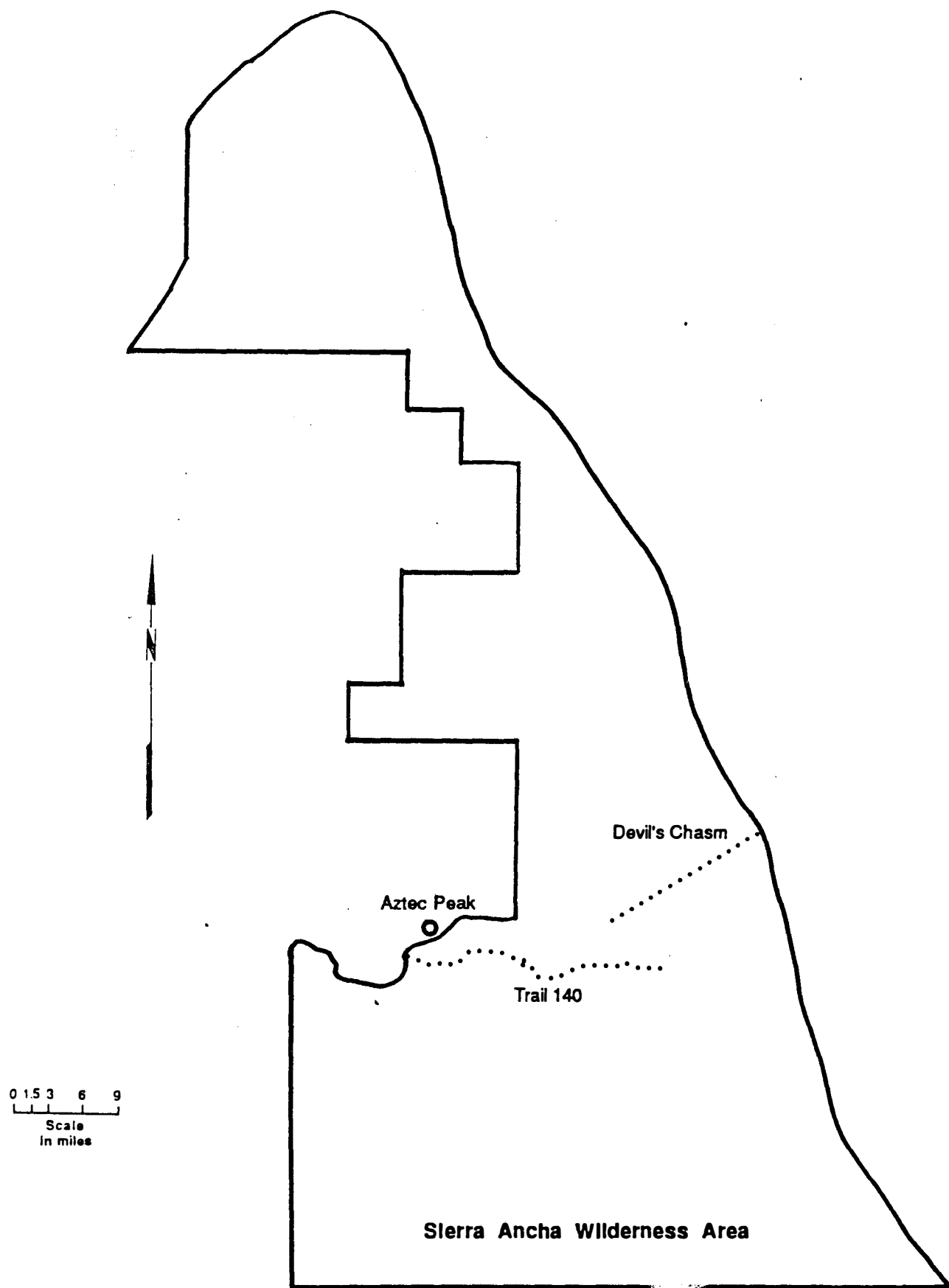


Figure 2

- downhill along USFS Trail 140. The presence of alligator juniper in the lower elevations of Trail 140 probably accounts for the increase, as the wood of alligator juniper trunks and branches is a particularly favorable substrate for foliose and crustose lichens.
4. Terricolous lichens were most abundant in the lower elevations of Trail 140. Reduction in canopy shade probably creates habitats favorable for the growth of terricolous lichens.
 5. Devil's Chasm was relatively lichen-depauperate. The riparian zone itself is too shady for many common terricolous forms, and the chasm walls outside the narrow riparian zone too steep for the stable soil surfaces favored by terricolous forms. The bark of Arizona sycamore, the predominant tree in the riparian zone, exfoliates too fast for corticolous lichen growth. Much of the surrounding lithology was conglomerate, a rock substrate unfavorable to many crustose lichens.
 6. Air pollution or regional haze was apparent from the lookout tower atop Aztec Peak. The haze was most dense towards the west, southwest and south, also to the southwest and east. The northwest and northeast cleared; the north was altogether clear. Probable sources are the Phoenix area in the southwest and the Miami-Globe copper smelters in the southeast.
 7. Pollution-related thallus damage was not apparent in samples taken so far, but elemental analyses will better quantify the extent of pollutant accumulation.
 8. Table 2 contains a list of several lichen species which have been shown to be sensitive to various air pollutants. Photographs of some of these species are included with this report.
 9. Elemental analysis data for *Xanthoparmelia coloradoensis* and *Usnea hirta* consistently show low levels of lead, copper and sulfur accumulation in this wilderness area (Table 3). These data suggest that this wilderness area is currently one of the cleanest air quality sites of the seven areas studied during this project. The pristine condition of this wilderness area provides an excellent opportunity for establishment of a first rate air quality baseline. We strongly encourage the Forest Service to allocate funds for establishment of a comprehensive lichen biomonitoring program in this wilderness.
 10. A list of all lichen species collected from all wilderness areas during the course of this study is included for your information (Table 1).

Format of general species list for the Sierra Ancha Wilderness Area:

The following data are recorded for each species in the general species list (all species are listed alphabetically by genus):

1. current epithet (genus & species) with authors, nomenclature generally follows Egan (1987, 1989, 1990)
2. lichen growth form (ie fruticose, foliose, crustose, squamulose, umbilicate)
3. substrates (ie rock, soil, bark, decorticated wood)
4. specific collection site(s)

5. relative abundance (ie rare, locally common, common, abundant)
6. documented pollution sensitivity with appropriate literature citation(s) (ie sensitive, intermediate, tolerant)
7. general comments (including occurrence on atypical substrates, unusual morphology, new species records for Arizona, descriptive information for unidentified specimens.
8. deposition of specimens (ie BYU Herbarium with duplicates to ASU)

**CHECKLIST OF LICHEN SPECIES
SIERRA ANCHA WILDERNESS AREA, ARIZONA**

Acarospora chlorophana (Wahlenb. ex Ach.) Massal.

Growth form: crustose with effigurate margins

Substrate: on cliffs (sandstone)

Site(s): Aztec Peak

Relative abundance: locally common

Pollution sensitivity: sensitive to sulfur dioxide
(Hale, 1982)

Comments: none

Deposition of specimens: BYU Herbarium #14374 (duplicate
specimen sent to ASU)

Acarospora oxytona (Ach.) Massal.

Growth form: crustose with lobate margins

Substrate: on rock (igneous)

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14375 (duplicate
specimen sent to ASU)

Anaptychia palmulata (Michaux) Vainio

Growth form: foliose

Substrate: on oak bark

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14373 (duplicate
specimen sent to ASU)

Aspicilia alphoplaca (Wahlenb. in Ach.) Poelt & Leuck.

Growth form: crustose with well-developed lobes

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: rare to locally common

Pollution sensitivity: sensitive to sulfur dioxide (Marsh &
Nash, 1979)

Comments: none

Deposition of specimens: BYU Herbarium #14376

Aspicilia caesiocinerea (Nyl. ex Malbr.) Arnold

Growth form: crustose

Substrate: on rocks

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14383

Aspicilia calcarea (L.) Mudd

Growth form: crustose

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14377

Aspicilia cinerea (L.) Korber

Growth form: crustose

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14378 (duplicate specimen sent to ASU)

Aspicilia quartzitica W. Weber

Growth form: crustose

Substrate: on rocks

Site(s): Aztec Peak

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14531

Buellia punctata (Hoffm.) Massal.

Growth form: crustose

Substrate: on alder bark

Site(s): near workman creek falls

Relative abundance: rare

Pollution sensitivity: tolerant (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14384

Buellia erubescens Arnold

Growth form: crustose

Substrate: on juniper bark, on alder bark

Site(s): USFS Trail 140, Workman Creek Falls

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14385, 14386

Caloplaca arizonica Magn.

Growth form: crustose

Substrate: on juniper bark

Site(s): USFS Trail 140

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14394

Caloplaca cerina (Ehrh. ex Hedwig) Th. Fr.

Growth form: crustose - obsolete

Substrate: on oak bark

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: sensitive-intermediate
(Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14387

Caloplaca chrysophthalma Degel.

Growth form: crustose

Substrate: on juniper bark, on alder bark

Site(s): USFS Trail 140, Devil's Chasm

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14388, 14396

Caloplaca cinnabarina (Ach.) Zahlbr.

Growth form: crustose

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14390 (duplicate
specimen sent to ASU)

Caloplaca discolor (Willey) Fink

Growth form: crustose

Substrate: on juniper bark, bark at base of sycamore tree

Site(s): USFS Trail 140, Devil's Chasm

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14392, 14393

Caloplaca flavovirens (Wulfen) Dalla Torre & Sarnth.

Growth form: crustose

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14389 (duplicate specimen sent to ASU)

Caloplaca sideritis (Tuck.) Zahlbr.

Growth form: crustose

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14395

Candelaria concolor (Dickson) B. Stein

Growth form: foliose - subfruticose

Substrate: on rocks, on Dermatocarpon sp.

Site(s): Devil's Chasm near stream

Relative abundance: locally common

Pollution sensitivity: sensitive-intermediate
(Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14397, 14398

Candelariella deflexa (Nyl.) Zahlbr.

Growth form: crustose

Substrate: on decorticated juniper wood

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14399

Candelariella rosulans (Mull. Arg.) Zahlbr.

Growth form: crustose with lobulate margins

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14400 (duplicate specimen sent to ASU)

Candelariella vitellina (Hoffm.) Mull. Arg.

Growth form: crustose

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14401

Cetraria coralligera (W. Weber) Hale

Growth form: foliose (densely isidiate)
Substrate: on decorticated juniper wood, on decorticated wood
Site(s): USFS Trail 140
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14402 (duplicate specimen sent to ASU),
14403

Chaenotheca furfuracea (L.) Tibell

Growth form: crustose
Substrate: on charred deadwood
Site(s): USFS Trail 140
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14404

Cladonia coniocraea (Flk.) Spreng.

Growth form: squamulose
Substrate: over rocks and decaying lignum
Site(s): USFS Trail 140
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14405 (duplicate
specimen sent to ASU)

Cladonia pyxidata (L.) Hoffm.

Growth form: squamulose
Substrate: on soil over rocks (sandstone)
Site(s): Aztec Peak
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14406

Collema furfuraceum (Arnold) Du Rietz

Growth form: foliose
Substrate: on alder bark
Site(s): Devil's Chasm
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14407

Cyphelium tigillare (Ach.) Ach.

Growth form: crustose

Substrate: on charred deadwood

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14408 (duplicate specimen sent to ASU)

Dermatocarpon miniatum (L.) Mann

Growth form: foliose, polyphyllous or monophyllous

Substrate: on rocks (igneous & sandstone)

Site(s): USFS Trail 140, Aztec Peak

Relative abundance: locally abundant

Pollution sensitivity: sensitive to sulfur dioxide (Marsh & Nash, 1979)

Comments: none

Deposition of specimens: BYU Herbarium #14409, 14410 (duplicate specimen sent to ASU)

Dermatocarpon moulinsii (Mont.) Zahlbr.

Growth form: foliose, umbilicate

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14413

Dermatocarpon reticulatum Magn.

Growth form: foliose, umbilicate, some specimens
polyphyllous

Substrate: on rocks

Site(s): Devil's Chasm, USFS Trail 140

Relative abundance: locally abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14411 (duplicate
specimen sent to ASU), 14412 (duplicate specimen sent
to ASU)

Dimelaena oreina (Ach.) Norman

Growth form: crustose with lobed margins

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14414 (duplicate
specimen sent to ASU)

Diploschistes scruposus (Schreber) Norman

Growth form: crustose

Substrate: on rocks

Site(s): Devil's Chasm, Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14415 (duplicate specimen sent to ASU), 14416 (duplicate specimen sent to ASU)

Diplotomma alboatrum (Hoffm.) Flotow

Growth form: crustose

Substrate: on juniper wood

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14417 (duplicate specimen sent to ASU)

Flavopunctelia darrowi (Thomson) Hale

Growth form: foliose

Substrate: on alder bark, mountain mahogany bark, oak bark

Site(s): Workman Creek Falls, Aztec Peak, Devil's Chasm

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: lower cortex tan - light brown

Deposition of specimens: BYU Herbarium #14418 (duplicate specimen sent to ASU), 14419, 14496

Flavopunctelia soledica (Nyl.) Hale

Growth form: foliose

Substrate: on burned wood, on juniper, on oak, on mountain mahogany

Site(s): USFS Trail 140, Devil's Chasm, Aztec Peak

Relative abundance: locally abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14420 (duplicate specimen sent to ASU), 14421, 14422 (duplicate specimen sent to ASU), 14423 (duplicate specimen sent to ASU), 14424

Heterodermia rugulosa (Kurok.) Wetm.

Growth form: foliose

Substrate: on oak bark

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14470

Hypocenomyce scalaris (Ach. ex Liljeblad) M. Choisy

Growth form: squamulose

Substrate: on burned wood

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: intermediate sensitivity (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14452 (duplicate specimen sent to ASU)

Hypocenomyce xanthococca (Sommerf.) P. James & G. Schneider

Growth form: crustose

Substrate: on decorticated wood

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14453

Lecanora argentata (Ach.) Malme

Growth form: crustose

Substrate: on alder bark, on juniper bark

Site(s): Near Workman Creek Falls

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14381, 14382

Lecanora caesiurubella subsp. saximontana Imsh. & Brodo

Growth form: crustose

Substrate: on decorticated wood

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14456

Lecanora cenisia Ach.

Growth form: crustose

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14457

Lecanora impudens Degel.

Growth form: crustose

Substrate: on oak bark

Site(s): USFS Trail 140

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14458 (duplicate specimen sent to ASU)

Lecanora muralis (Schreber) Rabenh.

Growth form: crustose with prominent lobes

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: locally common

Pollution sensitivity: intermediate - tolerant (Wetmore, 1987; Marsh & Nash, 1979)

Comments: none

Deposition of specimens: BYU Herbarium #14459

Lecanora novomexicana (B. de Lesd.) Zahlbr.

Growth form: crustose with prominent lobes

Substrate: on rocks (igneous)

Site(s): USFS Trail 140, Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14460 (duplicate specimen sent to ASU),
14461

Lecanora saligna (Schrader) Zahlbr.

Growth form: crustose, scant

Substrate: on decorticated wood

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14462 (duplicate specimen sent to ASU)

Lecidea atrobrunnea (Ramond in Lam. & DC.) Schaerer

Growth form: crustose

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14463 (duplicate specimen sent to ASU)

Lecidella stigmatea (Ach.) Hertel & Leuck.

Growth form: crustose

Substrate: on rocks

Site(s): USFS Trail 140, Devil's Chasm

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14464, 14465

Leptoloma membranaceum (Dickson) Vainio

Growth form: crustose, leprose

Substrate: on rocks (sandstone)

Site(s): Aztec peak

Relative abundance: locally common - abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14466

(duplicate specimen sent to ASU)

Leptocaulon albicans (Th. Fr.) Nyl. ex Hue

Growth form: fruticose

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14425 (duplicate specimen sent to ASU)

Leptogium cyanescens (Rabenh.) Korber

Growth form: foliose

Substrate: on rocks, on bark at base of a sycamore tree

Site(s): Devil's Chasm, USFS Trail #140

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14431 (duplicate specimen sent to ASU), 14434, 14435

Leptogium denticulatum Tuck.

Growth form: foliose

Substrate: on rocks (sandstone, igneous)

Site(s): Aztec Peak, Devil's Chasm

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14430 (duplicate specimen sent to ASU), 14432 (duplicate specimen sent to ASU)

Leptogium furfuraceum (Harm.) Sierk

Growth form: foliose

Substrate: on juniper bark, oak bark

Site(s): USFS Trail 140, Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14426 (duplicate specimen sent to ASU), 14427, 14428 (duplicate specimen sent to ASU)

Leptogium hirsutum Sierk

Growth form: foliose

Substrate: on rocks (sandstone)

Site(s): Aztec peak

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14429 (duplicate specimen sent to ASU)

Leptogium lichenoides (L.) Zahlbr.

Growth form: foliose

Substrate: on mossy rocks

Site(s): Devil's Chasm

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14433 (duplicate specimen sent to ASU)

Melanelia subargentifera (Nyl.) Essl.

Growth form: foliose

Substrate: on oak bark, on shaded rocks

Site(s): USFS Trail 140, vicinity of Workman Creek Falls, Aztec Peak

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14439 (duplicate specimen sent to ASU), 14441, 14442

Melanelia subolivacea (Nyl. in Hasse) Essl.

Growth form: foliose

Substrate: on mountain mahogany bark

Site(s): Aztec Peak

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14438

Melanelia substygia (Rasanen) Essl.

Growth form: foliose

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14440

Mycocalicium subtile (Pers.) Szat.

Growth form: thallus endoxylic, scant
Substrate: decorticated wood
Site(s): USFS Trail 140
Relative abundance: rare
Pollution sensitivity: unknown
Comments: this species is not lichenized
Deposition of specimens: BYU Herbarium #14451

Neofuscelia infrapallida (Essl.) Essl.

Growth form: foliose
Substrate: on rocks
Site(s): Devil's Chasm, USFS Trail 140
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14443, 14444

Ochrolechia androgyna (Hoffm.) Arnold

Growth form: crustose
Substrate: decorticated wood
Site(s): USFS Trail 140
Relative abundance: rare
Pollution sensitivity: sensitive (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14530

Ochrolechia pallescens (L.) Massal.

Growth form: crustose
Substrate: on juniper wood
Site(s): USFS Trail 140
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14454 (duplicate specimen sent to ASU)

Pachyospora verrucosa (Ach.) Massal.

Growth form: crustose
Substrate: on juniper bark, oak bark
Site(s): USFS Trail 140
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14436 (duplicate specimen sent to ASU), 14437

Pannaria leucophaea (Vahl) P. Jorg.

Growth form: squamulose

Substrate: on mossy rock

Site(s): Devil's Chasm

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14445 (duplicate specimen sent to ASU)

Parmotrema hababianum (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks

Site(s): Devil's chasm, Aztec Peak

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14449 (duplicate specimen sent to ASU), 14480

Peltigera membranacea (Ach.) Nyl.

Growth form: foliose

Substrate: on mossy rocks

Site(s): Devil's Chasm

Relative abundance: locally common

Pollution Sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14450 (duplicate

Pertusaria amara (Ach.) Nyl.

Growth form: crustose

Substrate: on decorticated wood (Alligator juniper)

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: this species is a new record for Arizona; our material is distinctly yellow-gray with large soralia, the medulla is KC+ red

Deposition of specimens: BYU Herbarium #14468 (duplicate specimen sent to ASU)

Pertusaria saximontana Wetm.

Growth form: crustose

Substrate: on decorticated wood (Alligator juniper)

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14467 (duplicate specimen sent to ASU)

Phaeophyscia cililata (Hoffm.) Moberg.

Growth form: foliose

Substrate: on alder bark

Site(s): Devil's Chasm

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14482

Phaeophyscia orbicularis (Necker) Moberg

Growth form: foliose

Substrate: on rocks

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: intermediately sensitive

(Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14483

Phaeophyscia sciastra (Ach.) Moberg

Growth form: foliose

Substrate: on rocks

Site(s): Aztec Peak

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14506

Physcia aipolia (Ehrh. ex Humb.) Furnr.

Growth form: foliose

Substrate: on oak bark

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to sulfur
dioxide (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14471 (duplicate specimen sent to ASU)

Physcia caesia (Hoffm.) Furnr.

Growth form: foliose

Substrate: on rocks

Site(s): vicinity of Workman Creek Falls

Relative abundance: rare

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Dewit, 1976)

Comments: none

Deposition of specimens: BYU Herbarium #14477

Physcia dubia (Hoffm.) Lettau

Growth form: foliose

Substrate: on rocks

Site(s): USFS Trail 140

Relative abundance: locally common - abundant

Pollution sensitivity: tolerant (Wetmore, 1985)

Comments: none

Deposition of specimens: BYU Herbarium #14472 (duplicate specimen sent to ASU)

Physcia phaea (Tuck.) Thomson

Growth form: foliose

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14484

Physcia stellaris (L.) Nyl.

Growth form: foliose

Substrate: on oak bark, mountain mahogany bark, alder bark

Site(s): Aztec Peak, USFS Trail 140, Workman Creek Falls

Relative abundance: locally abundant

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14473, 14474,

14475, 14476

Physcia subtilis Degel.

Growth form: foliose

Substrate: on rocks

Site(s): vicinity of Workman Falls Creek

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14481

Physconia enteroxantha (Nyl.) Poelt

Growth form: foliose

Substrate: on juniper bark, mossy burned wood, mountain
mahogany bark, mossy rocks, alder bark, oak bark

Site(s): USFS Trail 140, Aztec Peak, Devil's Chasm

Relative abundance: locally common - abundant

Pollution sensitivity: unknown

Comments: upper cortex gray-green to brown

Deposition of specimens: BYU Herbarium #14485 (duplicate
specimen sent to ASU), 14487, 14488, 14490, 14491,
(duplicate specimen sent to ASU), 14493

14492

Physconia grisea (Lam.) Poelt

Growth form: foliose

Substrate: on oak bark, on mossy rocks

Site(s): USFS Trail 140, Workman Creek Falls, Aztec Peak

Relative abundance: locally common - abundant

Pollution sensitivity: intermediately sensitive to sulfur dioxide (DeWit, 1976)

Comments: none

Deposition of specimens: BYU Herbarium #14469 (duplicate specimen sent to ASU), 14479, 14486, 14489

Physconia perisidiosa (Erichsen) Moberg

Growth form: foliose

Substrate: on oak bark

Site(s): USFS Trail 140

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this species is a new record for Arizona

Deposition of specimens: BYU Herbarium #14478

Placynthium nigrum (Huds.) Gray

Growth form: papillate - granulose

Substrate: on oak bark

Site(s): Devil's Chasm

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14494 (duplicate specimen sent to ASU)

Psora nipponica (Zahlbr.) G. Schneider

Growth form: squamulose

Substrate: on rocks (sandstone)

Site(s): Aztec Peak

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14495 (duplicate specimen sent to ASU)

Punctelia hypoleucites

Growth form: foliose

Substrate: on oak bark, alder bark, on rocks

Site(s): Devil's Chasm, Workman Creek Falls

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14446, 14455 (duplicate specimen sent to ASU), 14497 (duplicate specimen sent to ASU)

Punctelia subrudecta (Nyl.) Krog.

Growth form: foliose

Substrate: on alder bark, on juniper bark

Site(s): Workman Creek Falls, USFS Trail 140

Relative abundance: rare

Pollution sensitivity: intermediate sensitivity
(Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14447, 14448

Ramalina americana Hale

Growth form: fruticose

Substrate: on alder bark, fir bark

Site(s): Workman Creek Falls

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14502, 14503
(duplicate specimen sent to ASU)

Ramalina pollinaria (Westr.) Ach.

Growth form: fruticose

Substrate: on rocks

Site(s): vicinity of Workman Creek Falls, Aztec Peak

Relative abundance: locally common - abundant

Pollution sensitivity: sensitive (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium 14498 (duplicate
specimen sent to ASU), 14499

Ramalina sinensis Jatta

Growth form: fruticose

Substrate: on alder bark, fir bark

Site(s): Workman Creek Falls

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14500 (duplicate
specimen sent to ASU), 14501 (duplicate specimen sent
to ASU)

Rhizocarpon disporum (Naeg. ex Hepp) Mull. Arg.

Growth form: crustose

Substrate: on rock (igneous)

Site(s): USFS Trail 140

Relative abundance:

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14504 (duplicate
specimen sent to ASU), 14505 (duplicate specimen sent
to ASU)

Rhizocarpon intermediellum Rasanen

Growth from: crustose
Substrate: on rock
Site(s): Devil's Chasm
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14507

Rhizoplaca chrysoleuca (Sm.) Zopf

Growth form: umbilicate
Substrate: on rocks
Site(s): Aztec Peak, USFS Trail 140
Relative abundance: locally common
Pollution Sensitivity: sensitive to sulfur dioxide (Hale, 1982)
Comments: none
Deposition of specimens: BYU Herbarium #14508 (duplicate specimen sent to ASU), 14509

Rhizoplaca melanophthalma (DC. in Lam.& DC.) Leuck. & Poelt

Growth form: umbilicate
Substrate: on rocks
Site(s): Aztec Peak, USFS Trail 140
Relative abundance: rare - locally common
Pollution sensitivity: sensitive to sulfur dioxide (Hale, 1982)
Comments: none
Deposition of specimens: BYU Herbarium #14510, 14511

Rinodina confragosa (Ach.) Korber

Growth form: crustose
Substrate: on rocks
Site(s): Devil's Chasm
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14391

Scoliciosporum umbrinum (Ach.) Arnold

Growth form: crustose
Substrate: on rocks
Site(s): Aztec Peak
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14529

Tephromela atra (Huds.) Hafellner

Growth form: crustose

Substrate: on juniper bark, on decorticated wood

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: generally this species occurs on rocks

Deposition of specimens: BYU Herbarium #14379 (duplicate specimen sent to ASU), 14380

Umbilicaria phaea Tuck.

Growth form: umbilicate

Substrate: on rocks

Site(s): Aztec Peak

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14512

Umbilicaria torrefacta (Lightf.) Schrader

Growth form: umbilicate

Substrate: on rocks

Site(s): Aztec Peak, USFS Trail 140

Relative abundance: locally common - abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14513 (duplicate specimen sent to ASU), 14514 (duplicate specimen sent to ASU)

Umbilicaria vellea (L.) Ach.

Growth form: umbilicate

Substrate: on rocks

Site(s): Aztec Peak

Relative abundance: locally common - abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14515 (duplicate specimen sent to ASU)

Usnea hirta (L.) Weber ex Wigg.

Growth form: fruticose

Substrate: on burned wood, decorticated wood, juniper bark, alder bark, mountain mahogany bark

Site(s): USFS Trail 140, Workman Creek Falls, Aztec Peak

Relative abundance: locally common

Pollution sensitivity: sensitive to intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14516, 14517 (duplicate specimen sent to ASU), 14518 (duplicate specimen sent to ASU), 14519, 14520

Xanthoparmelia coloradoensis (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks (sandstone)

Site(s): Aztec Peak, Devil's chasm

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: material of this species from Devil's Chasm was
analyzed for S, Cu, & Pb content

Deposition of specimens: BYU Herbarium #14521, 14523

Xanthoparmelia lineola (Berry) Hale

Growth form: foliose

Substrate: on rocks

Site(s): Devil's Chasm

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14522

Xanthoria fallax (Hepp in Arnold) Arnold

Growth form: foliose

Substrate: on alder bark, burned wood, dead hardwood

Site(s): USFS Trail 140, Workman Creek Falls, Devil's
Chasm

Relative abundance: locally common

Pollution sensitivity: sensitive - intermediate
(Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14524, 14525
(duplicate specimen sent to ASU), 14526 (duplicate
specimen sent to ASU)

Xanthoria polycarpa (Hoffm.) Rieber

Growth form: foliose

Substrate: on oak bark

Site(s): USFS Trail 140

Relative abundance: locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14527

Combined species list for all wilderness areas:

Included with this report is a listing of all the lichen species from all seven Class I wilderness areas included in this project. This table includes current species names, general distribution information by wilderness and relative abundance information for each species. A total of 291 species in 82 genera were collected from all wilderness areas during the course of this project. Due to the fact that each wilderness area is somewhat unique in terms of substrates, microhabitats and physical factors, comparisons between wilderness areas based on absolute species numbers, or even relative abundance of selected species are probably invalid. Furthermore, there is some variance in the actual collecting time between wilderness areas. These species lists are preliminary and depending on the wilderness area, actually represent between 50 and 80% of the total lichen flora. Depending on the wilderness area somewhere between 7 and 12 days of additional collecting will be necessary to bring the list to between 90 and 100% completion.

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Acarospora							
cervina var.							
glaucocarpa				R	R-LC		
chlorophana	R-C	R-LC	LC				C
cinereoalba		R		LC	R-LC		
fuscata		C		C			LC
oligospora		R					
oxytona		LC	LC	LC			
peltastica		R					
scheicheri	R-C	LC					
strigata		C		LC		R	
sp. 1	R	R-C		R			R-LC
sp. 2	R	R					
sp. 3		R-LC					
sp. 4		R					
sp. 5		LA					
Anaptychia							
palmulata		C-A	LC			R-C	
Aspicilia							
alophlaca	R-LC	R-LC	R-LC	LC	LC	R	R
caesiocinerea	R-C		R				
calcareea		C	LC	LC	LC	R-LC	C
cinerea	C	C	C		R-LC	LC	C-A
contorta							R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Aspicilia (cont.)							
desertorum				R	LC		
radiosa		LC					
quartzitica	C		R-LC		R-LC		
sp. 1		R					
Bellemerea							
cinereorufescens				R-LC		R-LC	
Biatora							
botryosa				R			
Bryoria							
furcellata							A
simplicior							R
Buellia							
erubescens	R		R			R-LC	
lacteoidea							R-LC
lepidastra				R-LC			
mamillana		R					
puntata	R	R	R	R		R-LC	LC
retrovertens				R	R		
semitensis							R
spuria						R-LC	R
triphragmioides		R-LC					
turgescens	R						R-LC
sp. 1							R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Caloplaca							
arizonica		LC	C		LC-C	R-LC	
cerina	R	LC	R			R-LC	LC
chysophthalma	R-C	LC	LC	R-LC	LC		
cinnabarina		C	C	R	LC		
discolor		C	LC			R-LC	
durietzii	C	R-C			LC		
epithallina						R	
exsecuta		R					
flavovirescens	C		C	LC	LC	LC	R
fraudans	R						
holocarpa	R-C	LC				R	LC
microphyllina						LC	
modesta				C		R-LC	LC
pelodella		R		C	LC		
saxicola		R				R	R
sideritis	R		R				
Candelaria							
concolor var.							
effusa			LC	R	R	LC	
Candelariella							
aurella	C	C					
deflexa	R-C	R	R	R			
rosulans	C	R-LC	LC	R-LC		LC	

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Candelariella (cont.)							
submexicana	R			LC			
vitellina		R-C	LC				
xanthostigma					R		
Candelina							
submexicana						LC	
Carbonea							
vorticosa	R	R					
Catapyrenium							
lachneum	C	LC-A		LC	LC	R	
Cetraria							
coralligera			LC				
weberi		LC					R
Chaenotheca							
furfuracea			R				
Cladonia							
bacillaris						R	
cariosa		R					LC
chlorophaea		LC					
coniocraea			LC				LC
fimbriata						LC	
pyxidata	LC	LC	R		LC		LC

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Collema							
coccophorum		R				R	
furfuraceum		R	R		LC	R	
fuscovirens				R	R-LC	R-LC	
polycarpon	R-C			LC	LC		
subflaccidum		LA					
tenax		LC				R-LC	
texanum	R						
undulatum		R					
Cyphelium							
tigillare		R-LC	R				R
Dermatocarpon							
intestiniforme					C		LC
miniatum	LC	LC-A	LA		C		LC
moulinsii			R				R
reticulatum	LC-A	R-C	LA	LC	LC		LC
Dimelaena							
oreina	C	R	LC				LC
Diploschistes							
diacapsis					LC		
muscorum	R				R		
scruposus	R-C	R-C	LC			R	R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Diplotomma alboatrum			LC				
Endocarpon pulvinatum	R						
pusillum	R-C	LC		R	R		
wilmsoides	R						
Flavoparmelia caperata							LC
Flavopuntelia darrowi	R-LC		LC				R-LC
flaventior	R-C	R-LC			LC	R-LC	C
praesignis	R						LC
soredica	C-A	C	LA	R	LC	R-C	R-LC
Heppia lutosa	R						
Heterodermia hypoleuca							LC
rugulosa			R				
speciosa							R
Hyperphyscia adglutinata				LC	LC		
Hypocenomyce castaneocinerea							LC
friesii							LC

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Hypocenomyce (cont.)							
scalaris			R				LC
xanthococca			R				
Hypogymnia							
physodes							LC
Hypotrachyna							
pulvinata							C-A
Imshaugia							
aleurites							R-LC
placorodia		LC				R-LC	LC-A
Lasallia							
papulosa	LC						
Lecanora							
argopholis				R			
argentata		R	LC		R-LC	R	R-LC
caesiorubella			R				
subsp. saximontana							
carpineae							R
cenisia			R	R			R-LC
christoi		R		R-LC			
crenulata						R-LC	
dispersa		R					
garovaglii		R		R-LC			
impudens		R	R-LC				R-LC

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecanora (cont.)							
muralis	C	C	LC	C	LC	LC	
novomexicana	C		LC	R			
piniperda						R	R
polytropa	R						R
rugosella						LC	
rupicola							LC
saligna	R	R	R				R
sierrae		R				R	
symmicta						R	
thallophila					R		
valesiaca				R	R	R	
varia		R-LC				R	R
Lecidea							
atrobrunnea		R-LC	LC				R
auriculata		R-LC		R-LC			
botryosa	R						
elabens						R	
tessellata	C	C			LC	LC	LC
tornoensis							LC
turgidula		R-LC				LC	R
sp. 1		R					

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecidella							
carpathica		R				C	
euphorea		R-LC			R-LC	LC	LC
stigmatea		R	R-LC			LC	
viridans		LC					R
Lepraria							
finkii		R					R
Leprocaulon							
albicans	LC		R-LC				LC
Leptroloma							
membranaceum			LC-A			R	
Leptogium							
arsenei					R	LC	LC
cyanescens	LC	R-LC	C		LC	LC	LC
denticulatum	LC		LC	R		LC	R-LC
furfuraceum		LC	LC		LC	LC	R
hirsutum			R				
lichenoides	R		R		LC		
saturninum		R				R-LC	
sp.	R-LC						
Letharia							
vulpina		R					

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lichenothelia							
scopularia							R
Megaspora							
verrucosa		R	LC				
Melanelia							
exasperata		R-C		R			
halei						R	
incolorata		R-C					
olivacea						R	
olivaceoides					R		
subargentifera			R				
subolivacea	LC	C	R		R-LC		R-LC
substygia			LC				R
Mycocalicium							
subtile		R	R				R-LC
Neofuscelia							
nfrapallida	R-C	R	LC	R-LC	R-LC	C	
Crolechia							
androgyna		R	R			R	R
pallescens		LA	LC				LC
Pannaria							
leucophaea	R		R		R-LC	R	R
tavaresii							R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Parmelia sulcata							R
Parmeliopsis ambigua		LC					LC
Parmotrema hababianum	LC		R-LC		LC	LC	
Peccania arizonica	R	R		R			
Peltigera canina	LC	LC			LC		LC
collina		R					
malacea		LC					R-LC
membranacea			LC		R-LC		
Peltula euploca				R			
Pertusaria albescens							R
amara			LC				
arizonica							R
saximontana		LC	LC		LC	R-LC	
sommerfeltii							R
wulfenioides							C-A

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Phaeophyscia							
cernohorskyi		R			LC	LC	
ciliata		R	R				LC
hispidula							LC
orbicularis		R	R				R-LC
sciastra		R	R				
Physcia							
aipolia	R		LC		R-LC	LC	
alba		R					
albinea	R					R-LC	R
caesia	R		R	R	R	R-LC	LA
callosa	R						R-LC
crispa	R						LC
dubia		R-LC	LC-A	R	R-LC		
halei						R	R-LC
phaea			R				
stellaris	LC	C	LA	R-LC	R-LC	LC	R-LC
subtilis		R	R				LC
Physconia							
detersa	R				R-LC	R	
enteroxantha	R		LC-A		R-LC	R	
grisea		R	LC-A				
perisidiosa		R	R		R		

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Placynthium nigrum			R				
Polychidium muscicola	R						
sp. 1	R						
Pseudevernia intensa							C-A
Psora decipiens		LC-A			LC		
himalayana					R		
icterica	C-A			R-LC			
luridella					R	R	
nipponica	R		LC				R-LC
pseudorussellii					R		
tuckermanii		R			LC		
Punctelia hypoleucites	LC	LC	LC		R-LC		LC
subrudecta			R				R
Ramalina americana			R-LC				
pollinaria			LC-A				LC
sinensis		R	LC				R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Rhizocarpon							
disporum	C	LC	C	LC	LC	C	LC
geographicum					R		
intermediellum	R		R				
Rhizoplaca							
chysoleuca	LC	R-LC	LC			R-LC	
melanophthalma		LC	R-LC				R
Rinodina							
archaea	R						
bischoffii		R					
confragosa			R				
exigua		R				R	R
milvina		R					
pachysperma		C			R-LC	R	
pyrina							LC
Sarcogyne							
regularis		R					
sp.	R						
Scoliciosporum							
umbrinum			R				
Squamarina							
degelii		R		R			

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Staurothele							
catalepta		R		C		LC	LC
fuscocuprea	R-C						
rufa		R					
Tephromela							
atra		LC	LC				R
Thelidium							
pyrenophorum				R			
Thyrea							
pulvinata				LC			
Toninia							
caeruleonigricans		LC					
tristis		LC					
Trapeliopsis							
granulosa		R					R
Tuckermannopsis							
fendleri		LC					C
pinastri							LC
Umbilicaria							
hirsuta							R
phaea			R				
torrefacta		LC	LC-A				
vella			LC-A				

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Usnea							
arizonica							C
cavernosa							C
herrei							R
hirta		R-A	LC		R-LC	LC	R-LC
subfloridana							R-C
Verrucaria							
lecideoides	R						
muralis		LC					
nigrescens						R	
viridula		R		R			
Xanthoparmelia							
barbatica				R			
coloradoensis		C	LC	R-LC	LC	C	LC
conspersa	LC	LC					
cumberlandia	C	C		C	LC		R-LC
lineola	R-C	R	LC	LC			
monticola		R					
neoconspersa		R-LC					
neotaractica							R-LC
nigropsoromifera	R-C						
novomexicana	R					R	R
planilobata							R
plittii	C	R-LC		C			

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Xanthoparmelia (cont.)							
psoromifera	LC	C					R
somloensis	R	LC					
subramigera				C	LC		
weberi				R			
wyomingica	C						
sp. 1		C					
sp. 2		R					
Xanthoria							
elegans		R			LC	R-LC	LC
fallax	LC	LC	LC	LC	R-LC	R-LC	
polycarpa		R-LC	LC				R-LC
sorediata		LC				LC	

AIR POLLUTION SENSITIVE LICHEN SPECIES
(Material collected for elemental analyses)

TABLE 2: List of air pollution sensitive lichen species collected from Sierra Ancha Wilderness Area, Arizona. Growth form, substrate and site information is given for each species.

GENUS/SPECIES	GROWTH FORM	SUBSTRATE	COLLECTION SITE(S)
Dermatocarpon miniaturum	foliose	rock	Trail 140, Aztec Peak
Ramalina pollinaria	fruticose	rock	Workman Creek Falls, Aztec Peak
Rhizoplaca chrysoleuca	umbilicate	rock	Trail 140, Aztec Peak
Umbilicaria vellea	umbilicate	rock	Aztec Peak
Usnea hirta	fruticose	bark, lignum	Trail 140, Workman Creek Falls, Aztec Peak
Xanthoparmelia coloradoensis	foliose	rock	Aztec Peak, Devil's Chasm
Xanthoria fallax	foliose	bark	Trail 140, Workman Creek Falls, Devil's Chasm

Table 3: Elemental analysis data for selected species of lichens from reference sites in the Sierra Anchas Wilderness Area, September 1990.

Species Sites (substrate)	Pb (ppm)	Cu (ppm)	S (%)
<i>Usnea hirta</i>	32.8 (31-34)	13.8 (13-15)	.092 (.08-.10)
<i>Xanthoparmelia coloradoensis</i>	38.7 (32-43)	62.4 (59-65)	.185 (.12-.25)

BIBLIOGRAPHY

- Egan, Robert S. :1987. A Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada. THE BRYOLOGIST 90(2).
- Egan, Robert S. 1989. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition I. THE BRYOLOGIST 92(1): 68-72.
- Egan, Robert S. 1990. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition II. THE BRYOLOGIST 93(2): 211-219.
- Fields, R. D. and L. L. St. Clair. 1984. A comparison of methods for evaluation SO₂ impact on selected lichen species: *Parmelia cholorchora*, *Collema polycarpon* and *Lecanora muralis*. THE BRYOLOGIST 87: 297-301.
- Fields, R. D. and L. L. St. Clair. 1984. The effects of SO₂ on photosynthesis and carbohydrate transfer in the two lichens: *Collema polycarpon*, *Parmelia chlorochroa*. American Journal of Botany 71: 986-998.
- Gough, L. P. and J. A. Erdman. 1977 Influence of a coal-fired power plant of the element content of *Parmelia chlorochroa*. THE BRYOLOGIST 80: 492-501.
- Hale, M. E. 1983. The Biology of Lichens, pp. 1-190. Arnold Publishers, London.
- Lawrey, J. D. and Hale, M. E. 1981. Retrospective study of lichen lead accumulation in the northeastern United States. THE BRYOLOGIST 84: 449-56.
- Richardson, D. H. S., and E. Nieboer. 1981. Lichens and pollution monitoring. Endeavour, new Series 5 (3): 127-133.
- Rope, S. K. and L. C. Pearson. 1990. Lichens as Air Pollution Biomonitors in a Semiarid Environment in Idaho. THE BRYOLOGIST 93 (1): 50-61.
- Rushforth, S. R., L. L. St. Clair, J. D. Brotherson, and G. T. Nebeker. 1989. Lichen Community Structure in Zion National Park. THE BRYOLOGIST 85(2): 185-192.
- St. Clair, L. L. 1989. Report concerning Establishment of a Lichen Biomonitoring Program for the Jarbidge Wilderness Area, Humboldt National Forest, Nevada. U. S. Forest Service Technical Report
- Schutte, J. A. 1977. Chromium in two corticolous lichens from Ohio and West Virginia. THE BRYOLOGIST 80: 279-283.

Skye, E. 1979. Lichens as biological indicators of air pollution. *Annual Review of Phytopathology* 17: 325-341.

Sundstrom, K. R., and J. E. Hallgren. 1973. Using lichens as physiological indicators of sulfurous pollutants. *AMBIO* 2: 13-21.

Wetmore, C. M. 1981. Lichens and air quality in Big Bend National Park, Texas. *THE BRYOLOGIST* 84: 426-433.

Wetmore, Clifford M. 1987. Lichens and Air Quality in Saguaro National Monument. Technical report submitted to the US National Park Service, CX 0001-2-0034.

Wetmore, C. M. 1989. Lichens and air quality in Cuyahoga National Recreation Area, Ohio. *THE BRYOLOGIST* 92(3): 273-281.